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and the

# Stockbridge Principle of Plant Feeding

By WILLIAM H. BOWKER

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With
Compliments of the Author.

**Extract from Tribute**

**By WILLIAM H.** enry **BOWKER**

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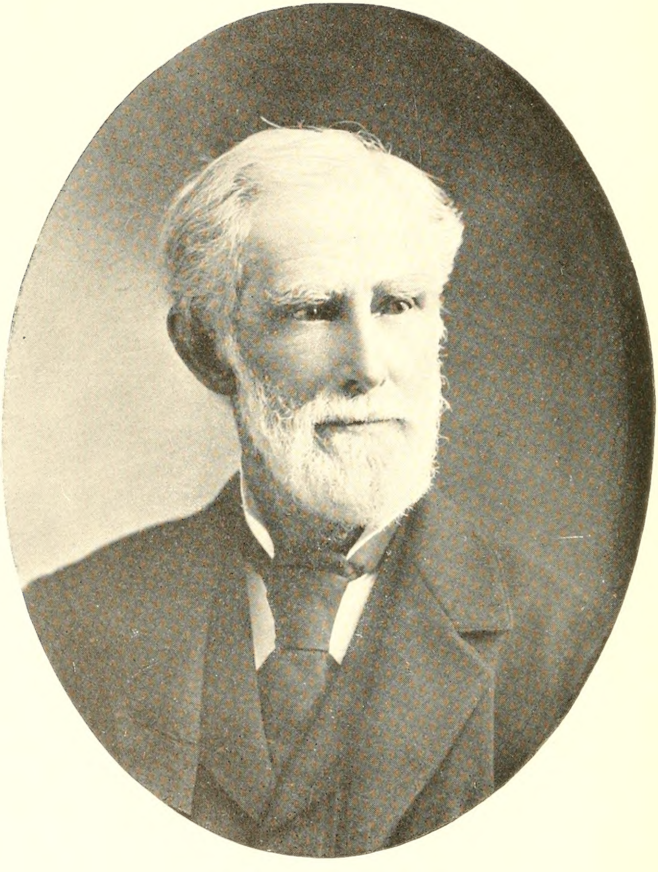

**LEVI STOCKBRIDGE**

Professor of Agriculture in the Massachusetts Agricultural College from 1871 to 1882, and President of the College from 1880 to 1882.

**1820—1904**

# LEVI STOCKBRIDGE

Biographical Note: Levi Stockbridge, a man of the type of Abraham Lincoln, was a farmer's son and for many years a practical farmer in Hadley, Mass. Except for such schooling as he received at the district school, and a few lectures in chemistry which he attended at Amherst College, he was self-taught. He possessed an alert mind, a retentive memory, and a marked talent for clear, forceful expression. Becoming distinguished as a leader and public speaker, he was sent for several terms to both branches of the Massachusetts Legislature. He was Massachusetts' first cattle commissioner, and in the course of his twenty-seven years' continuous service in that office he came to know nearly every farmer in the state, who looked up to and respected him. One of his greatest achievements was the quick and effective manner in which he stamped out a threatened epidemic of pleuro-pneumonia.

He was instrumental in securing for the state the Agricultural College located at Amherst, Mass., in spite of ridicule and strong opposition. He was its first farm superintendent; later, professor of agriculture, and for two years its president. During his connection with the college, at considerable personal inconvenience, he frequently endorsed the notes of the college to the local banks, thus tiding it over financial stress. He

was also " an ever-present help in time of need " to many worthy students. All the students were " his boys," and to all he was counselor and friend, and endearingly known as " Prof Stock."

Physically, he was tall and wiry, with a great capacity for work, which he never shirked. He was humorous, tactful, judicial, but outspoken; always sunny, hopeful, sane; of the right makeup to lead and teach young manhood. He sprang from the plain people and believed in them; thus he naturally abhorred a plutocracy and believed in every man's having a fair chance.

It is thought that he did as much to advance the cause of agricultural education and to popularize the chemistry of plant foods as any one man of his time. It was while he occupied the chair of professor of agriculture that he evolved the Stockbridge principle of plant feeding and the Stockbridge formulas which he freely published to the world, and which have made his name a household word in rural communities.

# THE STOCKBRIDGE PRINCIPLE OF PLANT FEEDING

If I were asked what was Professor Stockbridge's greatest contribution to agriculture, I should say that it was *not* his formulas for crop feeding by which he is so widely known; for, useful as these were, they were but stepping stones to a better knowledge of the object and use of fertilizers. His greatest contribution to agriculture, as it seems to me, was his *new conception of the office of fertility* in farm economy. Up to the time of the publication of the Stockbridge formulas, the practice had been to *manure the soil* in order to restore lost fertility and to supply deficiencies in the soil, as ascertained by a chemical or crop analysis of the soil. Stockbridge saw that this method was not a practical solution of the problem, for neither chemical nor crop analysis of the soil could be relied upon as a true guide to its enrichment. The chemist disclosed too much that was misleading and the crop too little that was conclusive. But, what is more to the point, Stockbridge saw that we had taken hold of the problem at the wrong end.

## A PRACTICAL SOLUTION

It was *not the soil, but the crop, that we should first consider*. We should study it and its needs, and supply it, as far as we were able, with the necessary elements of plant nutrition by the

use of properly balanced manures. In a word, he turned from the inert soil, which could not answer, to the living crop, which could, and put this question to it:

" *What shall I supply you* in excess of what you may obtain from the soil or air by your own habits and conditions of growth to make you a perfect and profitable crop? "

On the other hand, the farmer was asking him:

" *What shall I use* to produce profitable crops — how much and in what form? "

Starting, then, from the crop, with the farmer's question ever spurring him on, and with such data as he could find, he worked out his well-known formulas, which were published broadcast in 1876. And let me say here that besides being published in many agricultural papers and reports, more than half a million pamphlets containing them were distributed.

### FORMULAS NOT INFALLIBLE

He did not claim that his formulas were infallible, for he anticipated and announced, what we soon discovered in practice, that they would need to be modified, as experience should point the way. They served, however, a greater purpose even than Stockbridge dreamed at the time — they centered our thought and our study on the crop. From that time on we discussed *plant food and not soil food* — plant feeding instead of soil manuring. " Feed the crop rather than the soil " was a frequent expression at that time.

It is well to observe here that crop formulas were not new. Ville and others had published

various sets. The Stockbridge formulas, however, were unique in this: that they were based not alone on the analysis of the crop, but on its power of absorption from all the sources of fertility — from soil, air, and water. Thus Stockbridge boldly prescribed:

"To produce fifty bushels of shelled corn per acre (without any stable manure) and its natural proportion of stover, *more* than the natural yield of the land, apply so many pounds each of nitrogen, potash, and phosphoric acid. Or, to produce a stated quantity of tobacco leaf of the desired color and texture, apply a stated quantity of plant food elements, preferably in the form of sulphates and nitrates."

Here, then, for the first time, *a definite way was prescribed* to attain a definite object. It was a startling proposition, and, as might be expected, it brought ridicule from many quarters, but Stockbridge did not allow that to disturb him. He knew that the commercial farmer needed a tangible starting point. He knew that to consider the needs of the crop, the living thing, both as to amount and kind of plant food, rather than the needs of the soil, an unknown and unknowable quantity, was not only a common-sense way of meeting the problem of plant nutrition, but a very direct way of helping the farmer out of the quagmire of doubt.

### INSURE THE CROP

The formulas might not be accurate; in some cases they might supply excessive amounts of plant food elements and apparently be very wasteful, yet he believed that in the end it was

better economy to apply too much and *insure a crop* than use too little and *lose a crop.* Nevertheless, as Professor Stockbridge anticipated would be the case, the fertilizers based on his formulas were modified from time to time as we gained light, chiefly by the reduction of nitrogen and the increase of phosphoric acid, as it was found that many crops were able to gather from natural sources, through bacterial action or otherwise, some part of the required nitrogen, and that an excess of available phosphoric acid would hasten maturity. It was also found that to supply the full complement of nitrogen in addition to what the crop would assimilate for itself tended in many cases to produce an unbalanced growth; yet, on the other hand, it was found that in some cases, especially where a forced growth or a tender leaf was required, an excess of nitrogen was desirable. Thus it will be seen that the crop was both the starting and the objective point. Not only its chemical needs, but its habits and conditions of growth, the object for which it was grown, and its market qualities, were all factors which influenced the composition or modification of the fertilizers; and the same factors are as potent to-day. Thus, since it was the crop that chiefly concerned Professor Stockbridge, how natural and sensible was his question: "What shall I supply you to make you a perfect and profitable crop?"

### POTENTIAL FERTILITY

Let us now consider for a moment another phase of the subject, namely, the potential

fertility of the soil, or "the natural yield," to which Professor Stockbridge frequently referred. It has been known for a long time that practically all tillable soils are rich in plant food elements, and yet many of them are barren, and most of them will not produce profitable crops without the aid of manure or fertilizer.

Prof. Frederick D. Chester, of Delaware, states in an able bulletin recently published:

"An average of the results of 49 analyses of the typical soils of the United States showed per acre for the first eight inches of surface 2,600 pounds of nitrogen, 4,800 pounds of phosphoric acid, and 13,400 pounds of potash. The average yield of wheat in the United States is 14 bushels per acre. Such a crop will remove 29.7 pounds of nitrogen, 9.5 pounds of phosphoric acid, 13.7 pounds of potash.

"Now, if all the potential nitrogen, phosphoric acid, and potash could be rendered available, there is present in such an average soil, in the first eight inches, enough nitrogen to last ninety years, enough phosphoric acid for five hundred years, and enough potash for one thousand years."

In a word, potential fertility represents plant food which is so tightly locked up that it is not available for present needs and becomes available only through the process of decay and disintegration, which is too slow to meet the requirements of the commercial farmer. Stockbridge realized the situation, but instead of asking the soil how much of the potential fertility could be depended upon for each crop (a question which will never be satisfactorily answered), he went to the crop and asked it how

much it was necessary to supply for a stated yield over and above the natural yield of the land. In all cases he found it to be a very small quantity. For the corn crop, not over 200 pounds of nitrogen, potash, and phosphoric acid was necessary, which the crop would return fiftyfold (at least five tons in stalk and grain), so little to produce so much, and yet, if this little quantity of 200 pounds was not supplied, the crop would be a failure.

### THE LITTLE ESSENTIAL BALANCE

It was this little essential balance of available plant food which stood between success and failure that concerned Professor Stockbridge, as it concerns every farmer to-day. Although it was small, he did not deem it wise to depend upon the potential fertility of the soil to supply it, or even any considerable part of it. For the commercial farmer it was too risky and uncertain. To insure a crop, as far as one was able, was a cardinal principle with him; not to do it was, in his eyes, almost a crime. But he felt that all these things would right themselves as we came to know more about farm crops and their environment.

### THE SINGLE ELEMENT DOCTRINE

As bearing on the economy of his system of plant feeding, I want to quote here one of his apt illustrations. He said in effect:

" In a sense the farmer is a manufacturer and the soil is his machine, into which he puts plant food, and out of which, by the aid of nature and his own efforts, he

takes his product at harvest time. If the soil machine is a good one, so much the better. If it has a balance of crop-producing power to its credit, let us preserve that balance for an emergency. Let us not draw on it for present needs."

He had no patience with the so-called *single-element doctrine,* which depends for its success on the potential fertility — no patience with the farmer who was trying to find out for himself if he could leave out any one of the three leading elements of plant nutrition (nitrogen, potash, and phosphoric acid), or how little of each he could get along with. That was a proper subject for the scientific worker to investigate, but until we knew more about it, the practical farmer, who had his living to make and bills to pay, should not tinker with it. To Stockbridge it meant, in the end, improvident farming. At best, the farmer had to take great chances, especially with the weather, — the largest factor in crop raising, over which he had no control, — but he should take no chances with the things which he could control. Among these were the amount and kind of manure which he applied to his crops. Thus, if he hoped for a stated crop he should at least fertilize intelligently for that crop. For the man who was dependent on his crops any other course was unwise. Moreover, any other course would leave the soil machine in a poorer condition than he found it. Broadly speaking, to encourage him to take out more than he put back was not only bad economy, but bad morals, and should be discouraged, for in the end it would lead to crop bankruptcy.

### RAISING THE STANDARD

It is needless to say that the farmers appreciated this bold course. As Stockbridge put it, they jumped on his wagon before he was ready to start. He was indeed their prophet, who led them out of the wilderness of speculation into the light of practical methods. As might be expected, this new conception of the use of chemical manures — or plant food, as he liked to call it — not only revolutionized all our notions of fertilization, but the entire fertilizer business as well. It immediately raised the standard of commercial manures from ordinary superphosphates, containing no potash, to "complete manures," many of them rich in potash. Special fertilizers for special crops or classes of crops were brought out by various makers, and the business received a new impetus and a new recognition in the community. It was put on a sound footing, from which it can never be displaced.

### STOCK FEEDING AND PLANT FEEDING

As in stock feeding we chiefly concern ourselves with the study of the animal and its needs, so in plant feeding we must make an intelligent study of *the needs of the living crop.* As we know how to feed the cow for milk or beef, so we must know how to feed the plant for leaf or seed. Not only must we know the amount of plant food to be supplied, based on crop requirements, but the form and association of the different elements must be considered; and in the study of this problem we must also continue to study the soil, its potential fertility, its physical and

chemical characteristics, and particularly the lower orders of life which it contains, the bacteria and other unseen forces. In short, we must continue our study of all the sources and forces of fertility, to the end that we may know what each contributes to the upbuilding, not necessarily of the soil, but of the crop life above the soil. Thus did Stockbridge teach and practice.

### GOOD PRACTICE AND GOOD SCIENCE

As Stephenson made practical the discovery of Watts, as Singer improved upon the invention of Howe, so Stockbridge took the teachings of Liebig and Johnson, the tables of Wolf, and the experiments of Goessmann, Atwater, and Sturtevant, and applied them to practical and useful ends. While the system of plant feeding which he employed, or perhaps I should say, the method of application as prescribed in his formulas, did not appeal to the scientific mind in the beginning, it did appeal to the practical farmers, for it met their needs as no other method ever before had done. As good practice and good science must agree in the end, so I believe the scientific world is coming to agree with the practical farmer that the system and the method of application for which Stockbridge stood and labored is as truly scientific as it is thoroughly practical, and to accord him a high place among the workers for the advancement of scientific as well as practical husbandry.